Fish & Wildlife Division

WILDLIFE CONSERVATION AND BIODIVERSITY SECTION

The Use of Call Playbacks for Censusing Loggerhead Shrikes in Southern Alberta

Alberta Species at Risk Report No. 67

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

The Use of Call Playbacks for Censusing Loggerhead Shrikes in Southern Alberta

David R. C. Prescott

Alberta Species at Risk Report No. 67

March 2003

Project Partners:

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Environment Canada Environnement Canada

Publication No.: I/104
ISBN: 0-7785-2817-0 (Printed Edition)
ISBN: 0-7785-2818-9 (On-line Edition)
ISSN: 1496-7219 (Printed Edition)
ISSN: 1496-7146 (On-line Edition)

Illustration: Brian Huffman

For copies of this report, contact:

Information Centre – Publications
Alberta Environment / Alberta Sustainable Resource Development
Main Floor, Great West Life Building
9920 108 Street
Edmonton, Alberta, Canada T5K 2M4
Telephone: (780) 422-2079

OR

Information Service
Alberta Environment / Alberta Sustainable Resource Development
#100, 3115 12 Street NE
Calgary, Alberta, Canada T2E 7J2
Telephone: (403) 297-3362

OR

Visit our web site at:
http://www3.gov.ab.ca/srd/fw/riskspecies/

This publication may be cited as:

Prescott, D. R. C. 2003. The use of call playbacks for censusing Loggerhead Shrikes in southern Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 67, Edmonton, AB. 10 pp.

TABLE OF CONTENTS

LIST OF TABLES ii

LIST OF FIGURES ii

ACKNOWLEDGEMENTS iii

EXECUTIVE SUMMARY iv

1.0 INTRODUCTION 1

2.0 METHODS 1

2.1 Playbacks at Known Shrike Locations 2
2.2 Pilot Roadside Inventory 3

3.0 RESULTS 4

3.1 Playbacks at Known Shrike Locations 4
3.2 Pilot Roadside Inventory 7

4.0 DISCUSSION 7

5.0 LITERATURE CITED 9

LIST OF TABLES

Table 1. Cumulative number of 112 occupied sites found to be occupied by shrikes (singles or pairs), and pairs of shrikes at different stages of the playback sequence in 2002.....6

Table 2. Responses of shrikes (57 birds at 52 sites) that were at known distances from the speaker when the first playback was begun.....6

LIST OF FIGURES

Figure 1. Sonogram of Loggerhead Shrike call used during playback trials in 2002.....2

Figure 2. Location of occupied Loggerhead Shrike sites in southern Alberta in 2002.....5

ACKNOWLEDGEMENTS

I thank Ed Hofman, Reg Russell, and Leo Dube (Alberta Fish and Wildlife) for supplying records of recent Loggerhead Shrike nesting locations in southern Alberta, and Mark Piorecky and Henk Kiliaan for assistance with field work. M. Ross Lein (University of Calgary) provided digital copies of the call used in playbacks, as well as the sonograph (Figure 1). Ron Bjorge and Ken De Smet reviewed an earlier draft of the manuscript. The study was funded by the Canadian Wildlife Service (Andy Didiuk), and the Species at Risk Program of Alberta Sustainable Resource Development.

EXECUTIVE SUMMARY

Populations of the Loggerhead Shrike (*Lanius ludovicianus*) have declined markedly in many areas of North America in recent years. Populations in western Canada are now considered to be "Threatened" by the Committee on the Status of Endangered Wildlife in Canada. In Alberta, the species is considered to be a species of "Special Concern".

A variety of survey techniques have been used to monitor population size and distribution of shrikes in Alberta. These include Breeding Bird Surveys, surveys conducted from moving vehicles, ground searches of roadside habitats, and intensive block surveys. We experimented with the use of call playbacks to improve detection frequency of Loggerhead Shrikes during surveys by: (1) broadcasting recorded calls at sites known to be occupied by shrikes and determining response rates and characteristics; and (2) comparing the results of a pilot roadside survey using call playbacks with a "standard" driving survey (driving 50-70 km/hr without stops; Telfer et al. 1989) on the same routes.

In late May and early June 2002, observers visited sites occupied by shrikes in recent years to determine occupancy in 2002. Occupied sites were revisited within seven days by a second observer to test responses to playback. This observer first simulated a roadside driving survey by scanning the area within 500 m on either side of the provided GPS coordinates while driving 50-70 km/hr. The observer then returned to the provided coordinates and scanned the area for 120 s. A 20 s playback was then delivered from a portable tape player, followed by a 60 s waiting period, an additional 20 s playback, and a final 60 s observation period. Over 35% of sites were found to be occupied simply by driving past the site, with 57.1% of sites being confirmed to be occupied by the end of the pre-playback period. Playbacks elicited a substantial increase in the number of birds detected, with 73.2% of sites being confirmed to be occupied by the end of the first 20 s playback, and 83.9% by the end of the second playback. Strength of response decreased with increasing distance, with a notable decrease in response at distances >150 m. "Strong" responses were reported at 19.1% of sites, "medium" at 26.4%, "mild" at 30.0%, and "none" at 24.5%. There appeared to be no association between the strength of response and stage of nesting, cover type, and time of day.

The pilot roadside inventory included stopping for 90 s (including 20 s of playback) at 500 m intervals along two roadside routes (total of 163 km) in east-central Alberta. A second observer conducted a "standard" driving survey along the same routes within two days of the playback survey. The playback survey detected 229 % more shrikes and 200% more occupied sites than the standard driving survey. However, the playback survey took 305% longer to complete, and resulted in fewer birds (0.034) and occupied sites (0.031) per minute of survey effort that did the standard driving survey (0.042 for both measures).

Loggerhead Shrikes showed variable responses to call playback, but birds were more likely to be detected when playback was used. The playback technique therefore offers a valuable tool for enhancing surveys for shrikes. Further refinement is needed to make the surveys more time efficient for application over large geographical areas.

1.0 INTRODUCTION

Populations of the Loggerhead Shrike (*Lanius ludovicianus*) have declined markedly in many areas of North America in recent years. Breeding Bird Surveys indicate that continental populations have declined by 3.6%/year since 1966, with declines in Canada over the same period being 9.7%/year (Sauer et al. 2001). Populations in eastern Canada are now designated as being "Endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2001), whereas populations in western Canada are considered to be "Threatened" (COSEWIC 2001). In Alberta, the species no longer occupies the northern parts of its historical range (Prescott and Bjorge 1999), and is considered to be a species of "Special Concern" in the province (Alberta Sustainable Resource Development 2002).

Effective management of species at risk such as the Loggerhead Shrike requires accurate information on population size and distribution. In Alberta, a variety of survey techniques (other than the Breeding Bird Survey) have been used to gather this information. These include roadside surveys conducted from moving vehicles (Telfer et al. 1989; Johns et al. 2002), ground searches of roadside habitats (Kiliaan and Prescott 2002), and intensive block surveys (Bjorge and Prescott 1996, Bjorge and Kiliaan 1997). In general, roadside surveys are most applicable to inventories over a wide geographical area, and may be particularly applicable to shrikes, which are often found in association with roads. However, these surveys rely on shrikes being readily visible to the observer, and only a fraction of individuals (estimated to be 32.9% by Bjorge and Prescott 1996) will be encountered on each route. In this study we experiment with the use of call playbacks to improve detection frequency of Loggerhead Shrikes during roadside (and other) surveys. To our knowledge, the technique has never been used to inventory shrikes, but it has been widely used for a variety of other avian species (Johnson et al. 1981, Marion et al. 1981). We used two approaches to determine the utility of playbacks for this species: (1) broadcast recorded calls at sites known to be occupied by shrikes and determine response rates and characteristics; and (2) compare the results of a pilot roadside survey using call playbacks with a standard driving survey (Telfer et al. 1989) on the same routes.

2.0 METHODS

The playback call used to test for responses of shrikes was the "squawk" call, which is typically used by both members of a pair when agitated (for instance, when an observer approaches a nest). The particular recording used in this study was recorded near Provost, Alberta in 2000, with the observer recording the calls at approximately 2-3 m away with a hand-held microphone and a portable tape player. The sequence was 19 s in length, and consisted of approximately 12 calls, with several fainter calls from a second bird audible in the background. A sonograph of the call is given in Figure 1.

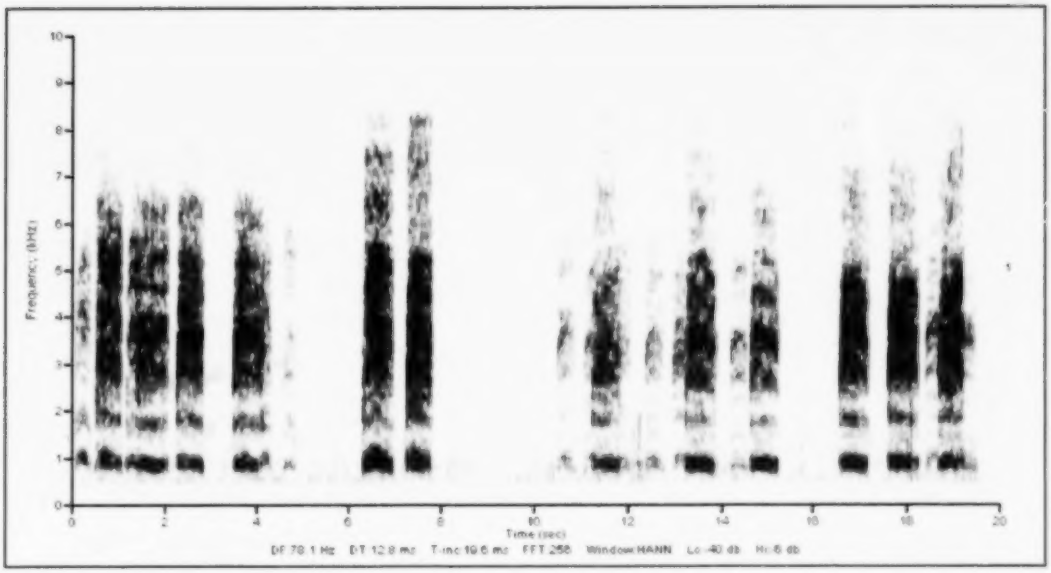

Figure 1. Sonogram of Loggerhead Shrike call used during playback trials in 2002.

2.1 Playbacks at Known Shrike Locations

Shrikes often return to previously used nesting areas (Kridelbaugh 1983, Collister and De Smet 1997). To identify sites potentially occupied in 2002, we reviewed recent (2000-2001) records in Alberta Fish and Wildlife's Biodiversity/Species Observation Database, and requested unpublished records from biologists and naturalists throughout the provincial range of the species. Observers then visited many of these sites in late May and early June to determine occupancy by shrikes in 2002. During these visits, additional occupied sites also discovered and recorded. In all cases, the observer recorded a GPS location where a different observer would be expected to find the shrikes from a roadside vantage point, if birds were present and visible.

To maximize the probability that recorded sites were still occupied by shrikes during playback trials, attempts were made to deliver playbacks within seven days of being discovered. The second observer was provided with a list of 'l shrike sites known to be occupied during 2002, and was asked to visit as many of these sites as possible. The observer first simulated a roadside driving survey by scanning the area within 500 m on either side of the provided coordinates while driving at between 50 and 70 km/hr. The observer then returned to the provided GPS coordinates and visually scanned the area for 120 s. Playback was then delivered for 20 s from a portable tape player, followed by a 60 s waiting period, an additional 20 s playback, and a final 60 s observation period. Playback was delivered at a volume where a human observer could recognize the call at >250 m under windless conditions. The speaker was rotated during playback so that sound would be broadcast towards all possible nesting or perching habitat. Occasionally, playback personnel would discover a previously unknown shrike location while en route to a known site. Playbacks were conducted immediately at these sites as well.

We recorded the following information during the playback sequence[1]: (1) the number of birds detected during each time period; (2) the position (distance from observer and whether obscured or in full view) of birds at the start of the first playback; (3) responses of each bird to the playback (fly toward speaker, vocalize, fly to less obscured perch, fly to high perch, fly to more obscured perch, appears aware but no obvious response); and (4) the time after the first playback begins to detect each bird. Following the playback trial, we also recorded: (5) the relative complexity of the habitat on a scale of 1 (simple) to 4 (complex), which was meant to reflect the difficulty of observing a shrike that may be present; (6) the overall response of birds at a site as either "none" (including birds already in view that appeared aware but did not show any other response), "mild" (playback made bird slightly more detectable), "medium" (bird was much more likely to be detected), and "strong" (obvious and aggressive response); and (7) the general habitat type at a site.

If no bird was detected at a site, the observer walked around the habitat for a maximum of 20 minutes while using playbacks and/or making noises ("pishing"/clapping hands, etc.) to determine whether or not the site was still occupied. Sites where no birds were found after this time were deleted from further consideration. For sites where birds were found during the playback sequence, a maximum 10 min search for nests was conducted. The stage of breeding (incubation, nestling or fledging) was recorded.

2.2 Pilot Roadside Inventory

A pilot roadside inventory using stops and playbacks was compared with a "standard" roadside inventory (driving only) along two parallel routes within the core range of shrikes in Alberta: a 73.5 km section of Highway 886 from Cereal (51°25'N; 110°47'W) to Buffalo (50°48'N; 110°41'W); and 89.5 km section of Highway 884 from Youngstown (51°32'N; 111°12'W) to Jenner (50°45'N; 111°12'W). The routes were approximately 30 km apart, and located near the northern edge of the Dry Mixedgrass Natural Subregion (Alberta Environmental Protection 1994). Both areas are primarily native grassland, with scattered shrubs (primarily willow) and widely spaced farmsteads with shelterbelts. Neither route was previously surveyed for shrikes in 2002, so the location of any occupied sites was unknown to the surveyors.

At the time of the roadside playback survey, the specific responses of Loggerhead Shrikes to playback at sites known to be occupied had not been analyzed. Therefore, the duration needed to detect shrikes at a site (if present), and the optimum spacing (based on response distances of birds to call playbacks) were not known. However, we assumed that responses to playback would be relatively rapid, and that shrikes would detect the playback at a distance similar to that of the observers (250 m). Playback stops were therefore spaced at 500 m intervals (based on odometer readings) along the routes, with the surveyor stopping only if woody habitat was present within 250 m of the stop. At each stop, the surveyor got out of the vehicle, scanned the area for 30 s, played the tape for 20 s, and waited 40 s to record any responses. A GPS reading was taken at stops where shrikes were discovered. A second observer conducted a "standard" roadside inventory (Telfer et

[1] The drive-by, pre-playback, playback and post-playback periods are hereafter collectively referred to as "the playback sequence".

al. 1989) by driving (without stopping) at 50-70 km/h along these same routes within two days of the playback survey. The position of birds was recorded, and the results (number of occupied sites, duration of survey) of the two methods compared.

3.0 RESULTS

3.1 Playbacks at Known Shrike Locations

A total of 182 shrike locations were found during the study, in an area extending from Stettler and Provost to the Montana border (Figure 1). Playbacks were conducted between 18 June and 6 July at 130 sites, including 114 that were known to have been occupied during prior visits in 2002, and 16 that were discovered immediately prior to delivery of playback. For previously identified sites, the mean number of days between discovery and return for playback was 7.1 $\pm$ 0.3 [SE] days (range 2-16 days). Of all playback sites, 31 (24.0%) were in primarily thorny buffalo-berry (*Sheperdia argentea*) habitat, 28 (21.7%) were in shelterbelts (usually *Caragana* sp.), 16 (12.4%) were in farmsteads, 16 (12.4%) were in shrubs (usually willows, *Salix* sp.) around dry sloughs, and 15 (11.6%) were in upland willows. The remainder (20.9%) were in habitats containing more than one of these habitat types. Playbacks were conducted across a range of habitat complexities, with the percentage of sites rated as 1 (simple), 2, 3, or 4 (complex) being 23.4%, 37.5%, 23.4%, and 15.65%, respectively. The stage of nesting on the date of playback was known for 29 nests, with 11 (37.9%) being in incubation, 12 (41.4%) containing nestlings, and six (20.7%) having recently fledged young.

Eighteen (13.8%) of the 130 playback sites were found to be unoccupied on the day of playback, and are not considered further. Birds were detected during the playback sequence at 100 sites (89.3%), with pairs being found at 38 sites (33.9%) (Table 1). Forty (35.7%) sites were found to be occupied simply by driving past the site, with 64 (57.1%) sites being confirmed to be occupied by the end of the pre-playback period. Playbacks elicited a substantial increase in the number of birds detected, with 82 (73.2%) sites being confirmed to be occupied by the end of the first 20 s playback, and 94 (83.9%) by the end of the second playback.

At the beginning of the first playback, the position of 57 birds at 52 sites was known, with the mean distance from the speaker being 100 $\pm$ 12 m (range 20-550 m). In general, the strength of response decreased with increasing distance, with a notable decrease in response strength at distances >150 m (Table 2). All (n=5) of the "none" responses in the highest distance class occurred at >225 m, suggesting an upper limit to response distance in this species. Overall, the most frequently observed response was for the bird to fly to a less obscured perch (53.2 %), followed by flying towards the speaker (33.9%). Four birds (3.7%) showed a negative response (headed for cover), with all such cases occurring <150 m from the speaker (Table 2).

Overall responses of birds were quantified at 110 playback sites, with 21 (19.1%) being "strong", 29 (26.4%) being "medium", 33 (30.0%) being "mild", and 27 (24.5%) sites yielding no response. Although sample sizes were insufficient for specific analyses, there appeared to be no association between the strength of response and variables such as stage of nesting, cover type, and time of day.

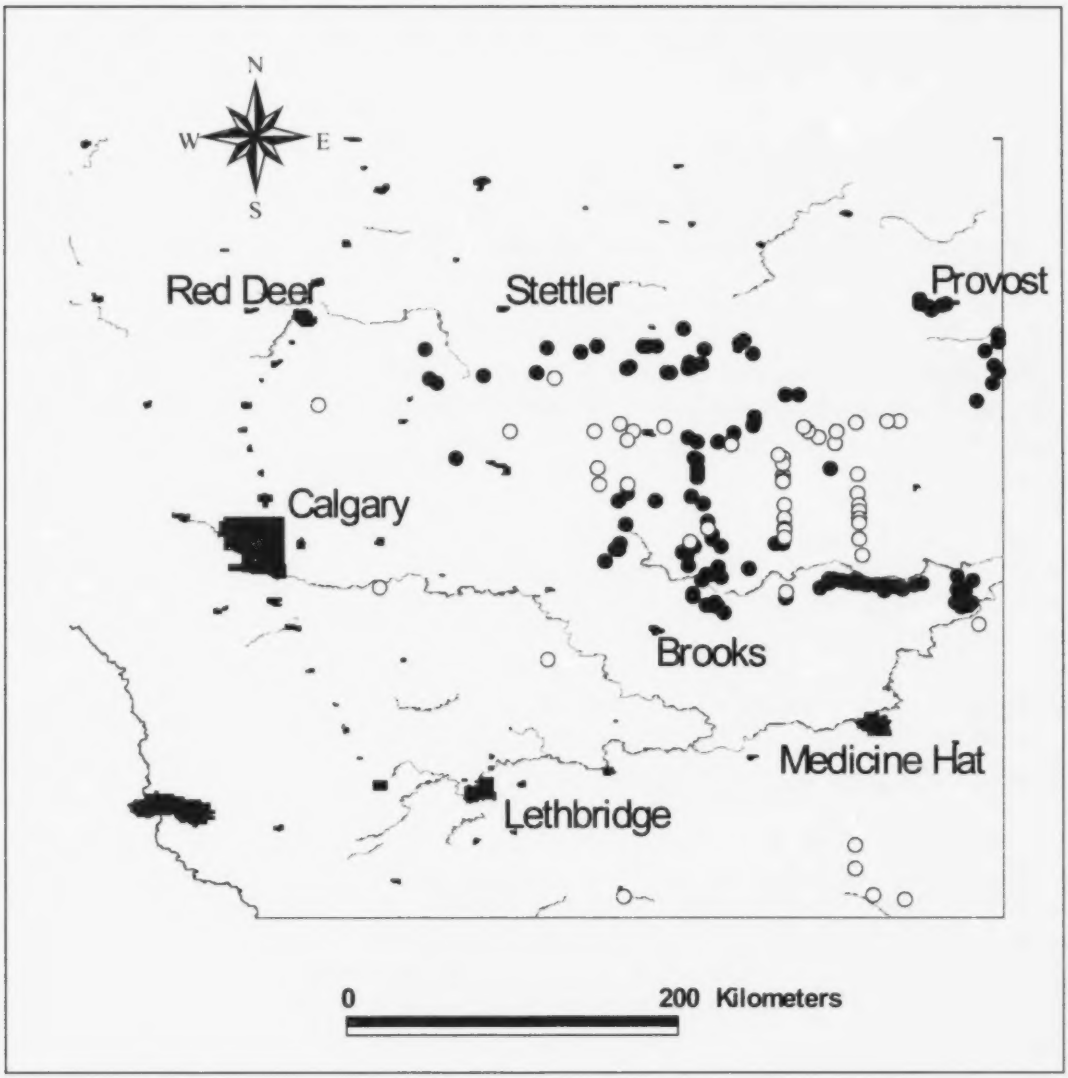

Figure 2. Location of occupied Loggerhead Shrike sites in southern Alberta in 2002. The solid symbols are sites where playbacks were broadcast.

Table 1. Cumulative number of 112 sites found to be occupied by shrikes (singles or pairs), and pairs of shrikes at different stages of the playback sequence in 2002.

	Stage of Playback Sequence					
	Drive-By	Pre-Playback	Playback #1	Inter-Playback	Playback #2	Post-Playback
Any Birds	40 (35.7%)	64 (57.1%)	82 (73.2 %)	88 (78.6%)	94 (83.9%)	100 (89.3 %)
Pairs	3 (2.7 %)	8 (7.1%)	20 (17.9%)	25 (22.3%)	30 (26.8 %)	38 (33.9%)

Table 2. Responses of shrikes (57 birds at 52 sites) that were at known distances from the speaker when the first playback was begun. "All birds" summarizes all responses recorded (109 birds at 90 sites), including birds of unknown distance. "None" was omitted for "All Birds" because individuals may have responded without being detected by the observer.

	High ——— Strength of Response ——→ Low				
Distance	Fly Towards Speaker *	Higher/Less Obscured Perch	Appears Aware	None	More Obscured Perch
<75 m	11 (40.7%)	7 (25.9%)	3 (11.1%)	5 (18.5%)	1 (3.7%)
75-150 m	8 (38.1%)	3 (14.3%)	6 (28.6%)	2 (9.5%)	2 (9.5%)
>150 m	1 (11.1%)	2 (22.2%)	1 (11.1%)	5 (55.6%)	0 (0.0%)
All Birds	37 (33.9%)	58 (53.2%)	10 (9.2%)	N/A	4 (3.7%)

*may include vocalization

3.2 Pilot Roadside Inventory

The roadside inventory using playbacks was conducted between 0830 and 1630 h on 28, 29 and 30 June. Conditions on all days were relatively windy (20-30 km/hr), which likely reduced playback detection distances by birds. The Cereal-Buffalo route was completed in 291 minutes, and included playbacks at 55 of 148 (37.2%) stops on the route (the remainder had no apparent habitat for shrikes). Ten shrikes at eight sites were detected. The Youngstown-Jenner route took 378 minutes to complete, with playback occurring at 55 of 180 (30.6%) stops on the route. Ten birds at eight sites were detected.

The "standard" driving survey was conducted between 0725 and 1040 in 1 July 2002, with winds <20 km/hr. Three birds were detected at three sites along the Cereal-Buffalo route during a 69-minute survey. The Youngstown-Jenner route produced four birds at four sites, and took 96 minutes to complete. Only one bird detected along the two routes was not detected during the roadside playbacks.

Overall, the playback survey detected 229 % more shrikes (23 versus 7), and 200% more occupied sites (21 versus 7) than the standard driving survey. However, the playback survey took 305% longer to complete (669 versus 165 minutes), and resulted in fewer birds (0.034) and occupied sites (0.031) per minute of survey effort that did the standard driving survey (0.042 for both measures).

4.0 DISCUSSION

Loggerhead Shrikes showed variable responses to call playback, but birds were, in general, more likely to be detected when playback was used. Part of this improvement comes from simply stopping at a site. For example, 36% of sites were confirmed as being occupied by driving by the site (this number is undoubtedly inflated, because the observer knew where to look), with confirmed occupancy rising to 57% following a 120 s scanning period at the site. However, detection rates increased steadily to almost 90% after playbacks and a post-playback period was considered, suggesting that playbacks yielded a substantial incremental increase in detection. The increase in the number of observed pairs was even more pronounced. Pairs were found at only 2.7% of sites during the drive-by, with rates increasing to 17.9% at the end of the first playback, and 33.9% following completion of the sequence. Shrikes typically responded quickly to the delivery of playback, with most birds either moving towards the speaker, or assuming a position where they were readily visible to the observer. For these birds, it is clear that delivery of playbacks enhanced their detection by the observer. However, birds at almost one-quarter of sites showed no obvious response to the tapes, and individuals at four sites moved quickly to more obscured vegetation when the call was broadcast.

The most telling account of the improvement offered by call playbacks is the 200% increase in the number of occupied sites found along routes when compared to a standard driving survey. However, routes using playback take substantially longer to complete, and consequently result in fewer detections per hour of survey effort. The efficiency of roadside playback surveys could be improved however, by eliminating the 30 s pre-playback period. Furthermore, because responses

were generally rapid, the post-playback period could be shortened from 40 s to 20 s. This would shorten the overall sequence from 90 s to 40 s. The time spent at each site could also be shortened by affixing the tape player (or speakers) to the outside of the vehicle, so the observer does not spend time setting up and removing the broadcast equipment at each site. Collectively, such time savings become increasingly important with increasing size of the geographical area being surveyed, and along routes where there is more potential nesting habitat (and therefore more playback stations) than the area were surveyed.

Call playbacks offer a valuable tool for conducting roadside surveys for shrikes, because they provide an index of population size or trend based on a larger percentage of the population than standard driving surveys. Playbacks may be especially useful in areas of complex habitat, where shrikes are often difficult to detect by an unaided observer. However, roadside surveys as a whole are limited in their utility because they monitor an unknown percentage of the overall population in an area. This percentage may be relatively high for Loggerhead Shrikes because substantial areas of shrubby habitat (e.g., farmsteads, shelterbelts) are distributed near roadsides (Bjorge and Prescott 1996). Nevertheless, call playbacks deserve further consideration for inventorying shrikes, and further refinements to field protocols may yield even more efficient field surveys. The third driving survey scheduled to be completed across the Canadian prairies in 2003 offers an opportunity to make further comparisons of the effectiveness of the playback protocols, and perhaps even include playbacks in the survey methodology.

5.0 LITERATURE CITED

Alberta Environmental Protection. 1994. Natural Regions of Alberta. Alberta Environmental Protection, Edmonton, AB.

Alberta Sustainable Resource Development. 2002. List of species currently listed under the Wildlife Act. http://www3.gov.ab.ca/srd/fw/escc/aaisar_1.html

Bjorge, R. R., and H. Kiliaan. 1997. Densities of Loggerhead Shrikes on study blocks in southeastern Alberta inventoried in both 1993 and 1996. Blue Jay 54: 217-219.

Bjorge, R. R., and D. R. C. Prescott. 1996. Population estimate and habitat associations of the Loggerhead Shrike, *Lanius ludvicianus*, in southeastern Alberta. Can. Field-Natur. 110:445 – 449.

Collister, D. M., and K. De Smet. 1997. Breeding and natal dispersal in the Loggerhead Shrike. J. Field Ornithol. 68: 273-282.

COSEWIC. 2001. Canadian species at risk. Committee on the Endangered Wildlife in Canada, Ottawa, ON. 38 pp.

Johns, B., D. Collister, R. Bjorge, K. De Smet, W. Harris, E. Wiltse, and S. Barry. 2002. Loggerhead shrike population trends in western Canada. Can. Wildl. Serv. Progr. Notes No. 218. 6 pp.

Johnson, R. R., B. T. Brown, L. T. Haight, and J. M. Simpson. 1981. Playback recordings as a special avian censusing technique. Pp. 68-75 in Estimating numbers of terrestrial birds (C. J. Ralph and J. M. Scott, eds.). Studies in Avian Biology No. 6. Cooper Ornithological Society, Lawrence, KS. 630 pp.

Kiliaan, H., and D. R. C. Prescott. 2002. Survey of the Loggerhead Shrike in the southern aspen parkland region, 2000-2001. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 46, Edmonton, AB. 10 pp.

Kridelbaugh, A. L. 1983. Nesting ecology of the Loggerhead Shrike in central Missouri. Wilson Bull. 95: 303-308.

Marion, W. R., T. E. O'Meara, and D. S. Maehr. 1981. Use of playback recordings in sampling elusive or secretive birds. Pp. 81-85 in Estimating numbers of terrestrial birds (C. J. Ralph and J. M. Scott, eds.). Studies in Avian Biology No. 6. Cooper Ornithological Society, Lawrence, KS. 630 pp.

Prescott, D. R. C., and R. R. Bjorge. 1999. Status of the Loggerhead Shrike (*Lanius ludvicianus*) in Alberta. Alberta Natural Resources Services, Edmonton, AB. 28 pp.

Sauer, J. R., J. E. Hines, and J. Fallon. 2001. The North America Breeding Bird Survey results and analysis. Version 2001.2, Patuxent Wildlife Research Center, Laurel, MD. URL: http://mbr-wrc.usgs.gov/bbs [Revision date: 24 June 2001].

Telfer, E. S., C. Adam, K. DeSmet, and R. Wershler. 1989. Status and distribution of the Loggerhead Shrike in western Canada. Can. Wildl. Serv. Progr. Notes No. 184. 4 pp.

List of Titles in This Series

(as of February 2003)

No. 1 Alberta species at risk program and projects 2000-2001, by Alberta Sustainable Resource Development, Fish and Wildlife Division. (2001)

No. 2 Survey of the peregrine falcon (*Falco peregrinus anatum*) in Alberta, by R. Corrigan. (2001)

No. 3 Distribution and relative abundance of the shortjaw cisco (*Coregonus zenithicus*) in Alberta, by M. Steinhilber and L. Rhude. (2001)

No. 4 Survey of the bats of central and northwestern Alberta, by M.J. Vonhof and D. Hobson. (2001)

No. 5 2000 survey of the Trumpeter Swan (*Cygnus buccinator*) in Alberta, by M.L. James and A. James. (2001)

No. 6 2000/2001 Brassy Minnow inventory at Musreau Lake and outlet, by T. Ripley. (2001)

No. 7 Colonial nesting waterbird survey in the Northwest Boreal Region – 2000, by M. Hanneman and M. Heckbert. (2001)

No. 8 Burrowing owl trend block survey and monitoring - Brooks and Hanna areas, by D. Scobie and R. Russell. (2000)

No. 9 Survey of the Lake Sturgeon (*Acipenser fulvescens*) fishery on the South Saskatchewan River, Alberta (June-September, 2000), by L.A. Winkel. (2000)

No. 10 An evaluation of grizzly bear-human conflict in the Northwest Boreal Region of Alberta (1991-2000) and potential mitigation, by T. Augustyn. (2001)

No. 11 Harlequin duck monitoring in the Northern East Slopes of Alberta: 1998-2000 preliminary results, by J. Kneteman and A. Hubbs. (2000)

No. 12 Distribution of selected small mammals in Alberta, by L. Engley and M. Norton. (2001)

No. 13 Northern leopard frog reintroduction. Raven River - Year 2 (2000), by K. Kendell. (2001)

No. 14 Cumulative effects of watershed disturbances on fish communities in the Kakwa and Simonette watersheds. The Northern Watershed Project. Study 3 Progress report, by T. Thera and A. Wildeman. (2001)

No. 15 Harlequin duck research in Kananaskis Country in 2000, by C.M. Smith. (2001)

No. 16 Proposed monitoring plan for harlequin ducks in the Bow Region of Alberta, by C.M. Smith. (2001)

No. 17 Distribution and relative abundance of small mammals of the western plains of Alberta as determined from great horned owl pellets, by D. Schowalter. (2001)

No. 18 Western blue flag (*Iris missouriensis*) in Alberta: a census of naturally occurring populations for 2000, by R. Ernst. (2000)

No. 19 Assessing chick survival of sage grouse in Canada, by C.L. Aldridge. (2000)

No. 20 Harlequin duck surveys of the Oldman River Basin in 2000, by D. Paton. (2000)

No. 21 Proposed protocols for inventories of rare plants of the Grassland Natural Region, by C. Wallis. (2001)

No. 22 Utilization of airphoto interpretation to locate prairie rattlesnake (*Crotalus viridis viridis*) hibernacula in the South Saskatchewan River valley, by J. Nicholson and S. Rose. (2001)

No. 23 2000/2001 Progress report on caribou research in west central Alberta, by T. Szkorupa. (2001)

No. 24 Census of swift fox (*Vulpes velox*) in Canada and Northern Montana: 2000-2001, by A. Moehrenschlager and C. Moehrenschlager. (2001)

No. 25 Population estimate and habitat associations of the long-billed curlew in Alberta, by E.J. Saunders. (2001)

No. 26 Aerial reconnaissance for piping plover habitat in east-central Alberta, May 2001, by D.R.C. Prescott. (2001)

No. 27 The 2001 international piping plover census in Alberta, by D.R.C. Prescott. (2001)

No. 28 Prairie rattlesnake (*Crotalus viridis viridis*) monitoring in Alberta – preliminary investigations (2000), by S.L. Rose. (2001)

No. 29 A survey of short-horned lizard (*Phrynosoma hernandesi hernandesi*) populations in Alberta, by J. James. (2001)

No. 30 Red-sided garter snake (*Thamnophis sirtalis parietalis*) education and relocation project – final report, by L. Takats. (2002)

No. 31 Alberta furbearer harvest data analysis, by K.G. Poole and G. Mowat. (2001)

No. 32 Measuring wolverine distribution and abundance in Alberta, by G. Mowat. (2001)

No. 33 Woodland caribou (*Rangifer tarandus caribou*) habitat classification in northeastern Alberta using remote sensing, by G.A. Sanchez-Azofeifa and R. Bechtel. (2001)

No. 34 Peregrine falcon surveys and monitoring in the Parkland Region of Alberta, 2001, by R. Corrigan. (2002)

No. 35 Protocol for monitoring long-toed salamander (*Ambystoma macrodactylum*) populations in Alberta, by T. Pretzlaw, M. Huynh, L. Takats and L. Wilkinson. (2002)

No. 36 Long-toed salamander (*Ambystoma macrodactylum*) monitoring study in Alberta: summary report 1998-2001, by M. Huynh, L. Takats and L. Wilkinson. (2002)

No. 37 Mountain plover habitat and population surveys in Alberta, 2001, by C. Wershler and C. Wallis. (2002)

No. 38 A census and recommendations for management for western blue flag (*Iris missouriensis*) in Alberta, by R. Ernst. (2002)

No. 39 Columbian mountain amphibian surveys, 2001, by D. Paton. (2002)

No. 40 Management and recovery strategies for the Lethbridge population of the prairie rattlesnake, by R. Ernst. (2002)

No. 41 Western (*Aechmophorus occidentalis*) and eared (*Podiceps nigricollis*) grebes of central Alberta: inventory, survey techniques and management concerns, by S. Hanus, H. Wollis and L. Wilkinson. (2002)

No. 42 Northern leopard frog reintroduction – year 3 (2001), by K. Kendell. (2002)

No. 43 Survey protocol for the northern leopard frog, by K. Kendell. (2002)

No. 44 Alberta inventory for the northern leopard frog (2000-2001), by K. Kendell. (2002)

No. 45 Fish species at risk in the Milk and St. Mary drainages, by RL&L Environmental Services Ltd. (2002)

No. 46 Survey of the loggerhead shrike in the southern aspen parkland region, 2000-2001, by H. Kiliaan and D.R.C. Prescott. (2002)

No. 47 Survey of native grassland butterflies in the Peace parkland region of northwestern Alberta – 2001, by M. Hervieux. (2002)

[illegible]ou range recovery in Alberta: 2001/02 pilot year, by T. Szkorupa. (2002)

No. 49 [illegible]p. rkland native grassland stewardship program 2001/02, by A. Baker. (2002)

No. 50 Carnivores and corridors in the Crowsnest Pass, by C. Chetkiewicz. (2002)

No. 51 2001 Burrowing owl trend block survey and monitoring, Brooks and Hanna areas, by D. Scobie. (2002)

No. 52 An evaluation of the ferruginous hawk population in Alberta based on recent trend data, by D.P. Stepnisky, G.L. Erickson, J. Iwaasa and B. Taylor. (2002)

No. 53 Alberta amphibian call surveys. A pilot year. Final report, by L. Takats and C. Priestley. (2002)

No. 54 Utilization of a roadside survey technique to survey burrowing owl (*Athene cunicularia hypugaea*) in southeastern Alberta, by J. Nicholson and C. Skiftun. (2002)

No. 55 Alberta species at risk program and projects 2001-2002, by Alberta Sustainable Resource Development, Fish and Wildlife Division. (2002)

No. 56 Developing a habitat-based population viability model for greater sage-grouse in southeastern Alberta, by C.L. Aldridge. (2001)

No. 57 Peregrine falcon surveys and monitoring in the Northeast Boreal Region of Alberta, 2001, by R. Corrigan. (2002)

No. 58 2002 burrowing owl trend block survey and monitoring, Brooks area, by R.F. Russell. (2002)

No. 59 Rare plant inventory of the eastern edge of the lower foothills natural subregion, west-central Alberta, by J. Doubt. (2002)

No. 60 Western (*Aechmophorus occidentalis*) and eared (*Podiceps nigricollis*) grebes of central Alberta: 2002 field summary, by S. Hanus, L. Wilkinson and H. Wollis. (2002)

No. 61 Inventory of western spiderwort (*Tradescantia occidentalis*) in Alberta: 2002, by S. Peters. (2003)

No. 62 Bullsnakes (*Pituophis catenifer sayi*) in Alberta: literature review and data compilation, by K.J. Kissner and J. Nicholson. (2003)

No. 63 Distribution of Ord's kangaroo rats in southeastern Alberta, by D.L. Gummer and S.E. Robertson. (2003)

No. 64 Lethbridge prairie rattlesnake conservation project: 2002/2003 progress report, by R.D. Ernst. (2003)

No. 65 Short-horned lizard (Phrynosoma hernandesi hernandesi) populations in Alberta – 2002 survey results, by J.D. James. (2003)

No. 66 Inventory and monitoring protocol for naturally occurring western blue flag (*Iris missouriensis*) in Alberta, by R.D. Ernst. (2003)